

Local Excision After Neoadjuvant Chemoradiotherapy in Carefully Selected Patients Initially Scheduled for Abdominoperineal Resection: Oncological Outcomes and Feasibility of Organ Preservation

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Abstract

Purpose

To evaluate the oncological outcomes of local excision (LE) and examine whether an organ-preserving strategy is feasible in patients who achieved a clinical complete response (cCR) or near-complete clinical response (near-cCR) after neoadjuvant chemoradiotherapy (nCRT), despite being initially scheduled for abdominoperineal resection (APR).

Methods

We retrospectively reviewed 134 patients with locally advanced rectal cancer who achieved cCR or near-cCR after nCRT and underwent LE at our institution. Patients were stratified into intended APR (iAPR) and intended sphincter-preserving surgery (iSPS) groups. Primary endpoints were postoperative complications and oncological outcomes.

Results

Of the 134 patients, post-LE pathology revealed ypT0 in 102 (76.1%), ypT1 in 9 (6.7%), and ypT2 in 23 (17.2%). Three patients (2.2%) required salvage surgery: two in the iAPR group and one in the iSPS group. The overall complication rate was 42.5% (57/134), most commonly perianal pain (34.3%, 46/134) and impaired wound healing (17.9%, 24/134). Median follow-up was 35.6 months (iAPR) and 38.7 months (iSPS). Local recurrence occurred in 10 patients, with a 3-year cumulative rate of 8.0% (7.6% in iAPR vs. 8.9% in iSPS). The 3-year overall survival, disease-free survival, stoma-free survival, and organ-preservation rates were 99.2%, 87.1%, 95.0%, and 88.4%, respectively.

Conclusion

LE offers favorable oncological outcomes and high organ preservation in low LARC patients with cCR/near-cCR after nCRT, including those initially considered for APR. However, complication and local recurrence rates remain substantial. Future research should optimize neoadjuvant strategies to boost pCR and organ preservation, and refine LE indications to reduce recurrence.

1. Introduction

Colorectal cancer is the second leading cause of cancer-related death worldwide, and approximately two million new cases are diagnosed each year.^[1] The standard treatment for locally advanced rectal cancer (LARC) is total mesorectal excision (TME) after preoperative chemoradiotherapy, a strategy that can achieve a local recurrence rate of less than 5% in experienced centers.^[2–3] For ultralow rectal cancers

invading the levator ani or anal sphincter complex, Abdominoperineal resection (APR) remains the main surgical approach. Approximately 15–20% of patients with low rectal cancer achieve a cCR or near-cCR after standard nCRT, and this response is associated with a favorable prognosis.^[4–5] However, patients undergoing radical surgery have a high rate of postoperative complications, such as anastomotic leakage, low anterior resection syndrome, and urogenital dysfunction, with a temporary or permanent stoma, which seriously affects the quality of life. Among patients with a cCR, the estimated risk of local regrowth under a watch-and-wait approach is 25%, and the 5-year local regrowth rate has been reported to be as high as 60%.^[6] For patients achieving a near-complete clinical response (near-cCR), radical surgery often necessitates either permanent stoma formation, ultralow anterior resection, or intersphincteric resection (ISR)—procedures associated with substantial functional morbidity. Conversely, for those with cCR or near-cCR, local excision (LE) offers a compelling alternative. LE not only mitigates the adverse effects of radical resection but also addresses the risk of residual tumor regrowth, potentially reducing local recurrence rates. Nevertheless, the long-term oncologic safety of this organ-preserving strategy remains an ongoing matter of debate.

To bridge this clinical equipoise, we conducted a retrospective analysis of 134 patients with very low rectal cancer at our institution, all of whom were classified as having achieved either cCR or near-cCR following neoadjuvant chemoradiotherapy (nCRT) and subsequently underwent LE. The primary endpoints encompassed postoperative morbidity, 3-year overall survival (OS), 3-year disease-free survival (DFS), 3-year cumulative local recurrence, 3-year organ preservation rate, and 3-year stoma-free survival. Our objective was to furnish robust real-world evidence to refine individualized treatment algorithms.

2. Materials and methods

2.1 Study population

We retrospectively reviewed 134 patients with locally advanced low rectal cancer treated in the Department of Colorectal Surgery at Fujian Medical University Union Hospital, between February 2017 and July 2025. Indications for local excision (LE) in this study were as follows: histologically confirmed rectal adenocarcinoma, with the inferior tumor margin ≤ 6 cm from the anal verge; pretreatment clinical stage cT3-4 or cN + M0; a maximum tumor diameter ≤ 2 cm following nCRT with MRI-assessed cCR or near-cCR; and absence of distant metastasis on pelvic MRI or PET-CT. All patients provided written informed consent, and those who elected to proceed with LE were enrolled. Patients with distant metastasis, adenosquamous cell carcinoma, signet-ring cell carcinoma, or mixed adenoneuroendocrine carcinoma were excluded from this study. The 134 patients were divided into an intended APR (iAPR) group and an intended sphincter-saving surgery (iSPS) group according to the distance from the lower tumor margin to the anal verge and the pretreatment cT stage. The iAPR group consisted of patients with an initial tumor distance from the anal verge of ≤ 3 cm and/or radiographic suspicion of levator ani

or external sphincter involvement. The remaining patients constituted the iSPS group. The flowchart detailing the patient selection and exclusion criteria is presented in Fig. 1.

After LE for patients who presented with ypT2 or higher disease, positive resection margins, poorly differentiated histology, lymphovascular invasion, or perineural invasion, salvage radical surgery was recommended. Conversely, those with ypT0–1 disease were candidates for continued rectal-preserving therapy. Notably, whereas a subset of patients with ypT2ycN0 disease and no other high-risk features opted for rectal preservation as well, based on their explicit refusal. The ethics committee approved the study protocol, and all patients provided written informed consent. Surgeons were stratified into two groups according to years of independent practice as attending colorectal surgeons: senior surgeons (≥ 10 years) and less senior surgeons (< 10 years).

2.2 Neoadjuvant treatment

Neoadjuvant radiotherapy included long-course radiotherapy (total dose, 50.4 Gy in 28 fractions; 1.8 Gy per fraction, 5 fractions per week), short-course radiotherapy (total dose, 25 Gy in 5 fractions; 5 Gy per fraction, 5 fractions per week), or split-course stereotactic body radiotherapy (Split-SBRT) (7 Gy per fraction, once weekly). Concurrent chemotherapy consisted of CapeOX (oxaliplatin plus capecitabine) or mFOLFOX6 (oxaliplatin, leucovorin, and fluorouracil). Some patients also received targeted therapy or immunotherapy during chemotherapy, including cetuximab, bevacizumab, Envafolelimab, or Camrelizumab. Total neoadjuvant therapy (TNT) was defined as radiotherapy combined with at least five cycles of CapeOX or eight cycles of mFOLFOX6.

2.3 Follow-up

Patients were followed every 3 months during the first 3 years, every 6 months during years 4 and 5, and annually thereafter. Follow-up assessments included serum carcinoembryonic antigen (CEA), carbohydrate antigen 19 – 9 (CA19-9), and digital rectal examination at the same intervals. Chest CT and abdominopelvic MRI were performed every 6 months during the first 3 years and annually thereafter. Colonoscopy was performed every 6 months during the first 3 years and annually thereafter. The final follow-up date was October 2025.

2.4 Statistical analysis

We compared categorical variables using the χ^2 or Fisher's exact test, and continuous variables using the Student's t-test or Mann–Whitney U test after assessing normality with the Shapiro–Wilk test. We generated survival curves using Kaplan–Meier and compared them with the log-rank test. A two-sided $P < 0.05$ indicated statistical significance. DFS was defined as the interval from LE to recurrence or metastasis. Planned salvage surgery was defined as radical surgery performed after LE for ypT2 stage, a positive pathological basal margin, lymphovascular invasion (LVI) or other high-risk pathological features. Passive salvage surgery was defined as radical surgery performed after LE because of subsequent local recurrence. The rectal circumference was divided into 12 clock-face sectors; tumors located from 11 to 1 o'clock, 2 to 4 o'clock or 8 to 10 o'clock, and 5 to 7 o'clock were defined as anterior,

lateral, and posterior wall tumors, respectively. Statistical analyses were performed using the SPSS software package for Windows (SPSS version 25.0, Chicago, IL, USA).

3. Results

3.1 Clinical characteristics

Among the 134 patients, 79 were male, and 55 were female, with a mean age of 59 years. At pretreatment diagnosis, 37 (27.6%) patients were clinical T2 stage, 50 (37.3%) were T3 stage, and 47 (35.1%) were T4 stage. Post-LE pathological staging revealed ypT0 in 102 patients (76.1%), ypT1 in 9 (6.7%), and ypT2 in the remaining 23 (17.2%). The median pre-treatment distance from the tumor to the anal verge was 3.0 cm (2.0–4.0 cm). In this study, 85 (63.4%) patients received TNT, 17 (12.7%) received targeted therapy, and 24(17.9%) received immunotherapy (Table 1).

Table 1
Baseline characteristics and oncological features

Age, years	iAPR group (n = 92)	iSPS group (n = 42)	P value
	58(50–68)	62(51–72)	0.229
Sex (%)	49(53.3)	30(71.4)	0.047
Male	43(46.7)	12(28.6)	
Female			
BMI,kg/m ² ,	22.67 ± 2.95	23.31 ± 4.03	0.288
Preoperative comorbidities(%)	30(32.6)	20(47.6)	0.096
Diabetes mellitus	16	6	
Hypertension	16	15	
Coronary heart disease	1	3	
Pretreatment CEA, ng/ml	2.95(1.80–5.58)	3.35(2.00-6.63)	0.430
Pretreatment CA199, IU/ml	12.78(6.55–21.55)	9.77(4.73–14.47)	0.081
Pretreatment vertical length of Tumor,cm	3.0(2.5-4.0)	3.0(2.0–4.0)	0.792
Pretreatment thickness of Tumor, cm	3.0(2.0–3.0)	3.0(2.0–3.0)	0.867
Pretreatment cT stage(%) ^a	24(26.1)	13(31.0)	<0.001
T2	26(28.3)	24(57.1)	
T3	42(45.7)	5(11.9)	
T4			
ASA (%) [*]	6(6.5)	3(7.1)	0.154
1	83(90.2)	34(81.0)	
2	3(3.3)	5(11.9)	
3			
Neoadjuvant radiotherapy regimen (%) ^a	9(9.78)	4(9.5)	1.000
Short-course	65(70.7)	30(71.4)	
Long-course	18(19.6)	8(19.0)	
Split-SBRT			

Age, years	iAPR group (n = 92)	iSPS group (n = 42)	P value
	58(50–68)	62(51–72)	0.229
Concurrent chemotherapy (%)	54(58.7)	23(54.8)	0.669
With-oxaliplatin	38(41.3)	19(45.2)	
Without-oxaliplatin			
Total neoadjuvant therapy (%)	64(69.6)	21(50.0)	0.029
Immunotherapy (%)	15(16.3)	9(21.4)	0.473
Targeted therapy (%)	14(15.2)	3(7.1)	0.193
Anti-EGFR	5	1	
Anti-VEGF	9	2	
Interval from radiation to surgery, weeks	19.4(12.0-31.3)	17.1(12.7–24.7)	0.405

BMI, body mass index; ASA, American Society of Anesthesiologists grade; Anti-EGFR, Anti epidermal growth factor receptor; Anti-VEGF, Anti vascular endothelial growth factor; Anti-PD-1, Anti programmed death 1.

^a Fisher exact test

3.2 Univariate comparison between the iAPR group and the iSPS group

Compared with the iSPS group, the iAPR group had more distal tumor location (3 cm vs. 5 cm; $P < 0.001$), a significantly higher proportion of cT4 stage (45.7% vs. 11.9%, $P < 0.001$), and a higher proportion of TNT (69.6% vs. 50.0%; $P = 0.029$). Among the 92 patients in the iAPR group, 69 (75.0%) had ypT0 stage, 5 (5.4%) had ypT1 stage, and 18 (19.6%) had ypT2 stage. Pathological T-stage distribution did not differ significantly between the iAPR and iSPS groups ($P = 0.424$) (Table 2).

Overall, 3(2.2%) patients underwent planned salvage surgery after LE. In the iAPR group, 2(2.2%) patients with positive deep resection margin underwent planned salvage APR after LE. In the iSPS group, 1 patient underwent planned salvage ISR because postoperative pathology revealed ypT2 disease with tumor cells within 1.2 mm of the deep resection margin. All three patients are currently alive without recurrence or metastasis.

Table 2
Postoperative clinical and pathological characteristics

Postoperative hospital stay, days	iAPR group (n = 92)	iSPS group (n = 42)	P value
	5.0(3.0–8.0)	6.0(3.0–8.0)	0.598
Postoperative vertical length of Tumor, cm	1.5(1.0–2.0)	1.5(1.0–2.0)	0.699
Postoperative thickness of Tumor, cm	1.0(1.0–2.0)	1.0(0.5–1.6)	0.082
Intraoperative distance from tumor to anal verge, cm	3.00(2.00–3.00)	5.00(4.00–5.00)	<0.001
Postoperative CEA, ng/ml	2.05(1.20–2.88)	2.31(1.40–4.18)	0.172
Postoperative CA199, IU/ml	8.47(5.37–15.21)	7.53(4.79–15.51)	0.623
TRG(%) ^a	69(75.0)	33(78.6)	0.079
0	11(12.0)	7(16.7)	
1	12(13.0)	1(2.4)	
2	0-	1(2.4)	
3			
Pathological tumor stage(%) ^a	69(75)	33(78.6)	0.424
ypT0	5(5.4)	4(9.5)	
ypT1	18(19.6)	5(11.9)	
ypT2			
Positive deep resection margin(%)	2(2.2)	0-	-

TRG, Tumor regression grade.

All patients with positive basal margins underwent planned salvage radical surgery.

^a Fisher exact test

3.3 Postoperative complications

The overall postoperative complication rate was 42.5% (57/134). The most common complications were perianal pain (34.3%, 46/134) and impaired rectal wound healing of the rectum (17.9%, 24/134). The overall complication rate did not differ significantly between the iAPR and iSPS groups (45.7% [42/92] vs. 35.7% [15/42], $P = 0.280$). Most patients with perineal pain were relieved after treatment with transanal irrigation, negative-pressure drainage, antibiotics and non-steroidal anti-inflammatory drugs, whereas among 24 patients with impaired rectal wound healing, 8 (33.3%) underwent diverting ileostomy, and in 1

patient the stoma remained unreversed at 1 year. Fourteen patients developed radiation-induced enteritis with rectal bleeding after surgery (10.4%, 14/134); most were relieved with conservative treatment, whereas one patient underwent diverting ileostomy followed by stoma reversal 4 months later. One patient in the iAPR group developed a postoperative rectovaginal fistula, which was managed with a diverting ileostomy that has not yet been reversed (Table 3).

Table 3
Postoperative complications after local excision^a

Overall complications(%)	iAPR group (n = 92)	iSPS group (n = 42)	P value
	42(45.7)	15(35.7)	0.280
Perianal pain (%)	36(39.1)	10(23.8)	
Impaired rectal wound healing(%)	17(18.5)	7(16.7)	
Radiation proctitis with rectal Bleeding impaired wound healing (%)	11(12.0)	3(7.1)	
Rectovaginal fistula (%)	1(1.1)	0-	

^aA patient could have more than one complication after LE.

3.4 Long-term outcomes

The median follow-up was 35.6 months (21.1–59.6) in the iAPR group group and 38.7 months (24.2–55.4) in the iSPS group (P = 0.869). During follow-up, local recurrence occurred in 10 patients, including 7 in the iAPR group and 3 in the iSPS group. In the iAPR group group, 6 cases were intraluminal recurrences, and 1 was mesorectal lymph node metastasis. All 3 local recurrence cases in the iSPS group were intraluminal recurrences. Among the 10 patients who developed local recurrence, the final ypT stages after local excision were ypT0 in 7, ypT1 in 2, and ypT2 in 1. The 3-year OS among the 10 patients with recurrence was 100%. During follow-up, distant metastasis was observed in 9 patients (6.7%), all of whom belonged to the iAPR group.. The metastatic sites included the lung (n = 7), liver (n = 1), and a single patient with concurrent bone, multiple lymph node, and posterior vaginal wall metastases. Salvage surgery was performed in 11 patients, with comparable salvage surgery rates between the iAPR and iSPS groups (8.7% vs. 7.1%, P = 1.000). Eight patients underwent APR, and the organ-preservation rate by patient count was 126/134 (94.0%). Overall, 18 patients underwent diverting ileostomy, and in 4 cases the stoma remained unreversed for over 1 year.

Compared with the iSPS group, the iAPR group had a significantly higher 3-year cumulative metastasis rate (10.9% vs. 0%, P = 0.033). No significant differences were observed in 3-year OS (98.9% vs. 100.0%, P = 0.776), 3-year DFS (86.2% vs. 91.1%, P = 0.351), 3-year cancer-specific survival (100% vs. 100%, P = 0.516), 3-year stoma-free survival (95.2% vs. 94.7%, P = 0.720), 3-year cumulative local recurrence rate

(7.6% vs. 8.9%, $P = 0.907$), or 1-year conditional local recurrence-free survival at 3 years (95.4% vs. 90.0%, $P = 0.336$) (Table 4A; Fig. 2).

When comparing the pretreatment cT4 group with the non-cT4 group, no significant differences were observed in 3-year OS (97.9% vs. 100.0%, $P = 0.824$), 3-year DFS (88.0% vs. 87.7%, $P = 0.708$), 3-year cancer-specific survival (100% vs. 100%, $P = 0.636$), 3-year stoma-free survival (92.8% vs. 96.2%, $P = 0.293$), 3-year cumulative local recurrence rate (5.2% vs. 9.5%, $P = 0.680$), or 3-year cumulative metastasis rate (10.1% vs. 6.0%, $P = 0.156$) (Table 4B).

Table 4
A. Long-term oncological outcomes by intended surgical strategy

Salvage surgery	iAPR group (n = 92)	iSPS group (n = 42)	P value
	8(8.7)	3(7.1)	1.000
Median follow-up, months	35.6(21.1–59.6)	38.7(24.2–55.4)	0.869
3-year overall survival(%)	98.9	100.0	0.776
3-year disease-free survival(%)	86.2	91.1	0.351
3-year cancer-specific survival(%)	100.0	100.0	0.516
3-year stoma-free survival(%)	95.2	94.7	0.720
3-year cumulative local recurrence rate(%)	7.6	8.9	0.907
3-year cumulative metastasis rate(%)	10.9	0-	0.033
3-year cumulative sphincter-preservation rate(%)	90.2	93.0	0.435
3-year cumulative organ-preservation rate(%)	88.9	87.6	0.972
1-year conditional local recurrence-free survival at 3 years, (%)	95.4	90.0	0.336
2-year conditional local recurrence-free survival at 3 years (%)	100	100	-

Table 4
B. Long-term oncological outcomes by Pretreatment cT stage

3-year overall survival(%)	Pretreatment cT4 group (n = 47)	Pretreatment non-cT4 group(n = 87)	P value
	97.9	100.0	0.824
3-year disease-free survival(%)	88.0	87.7	0.708
3-year cancer-specific survival(%)	100.0	100.0	0.636
3-year stoma-free survival(%)	92.8	96.2	0.293
3-year cumulative local recurrence rate(%)	5.2	9.5	0.680
3-year cumulative metastasis rate(%)	10.1	6.0	0.156
3-year cumulative sphincter- preservation rate(%)	90.3	91.4	0.822
3-year cumulative organ- preservation rate(%)	88.0	88.6	0.816

3.5 Factors associated with local recurrence after local excision

During follow-up, 10 patients developed local recurrence. In one patient, PET-CT after nCRT showed a focal, mildly hypermetabolic lesion in the rectal mucosa, suggesting slight residual activity, along with a suspected tiny mesorectal lymph node. After discussing the findings, the patient and family refused radical surgery, and recurrence occurred after LE. Nine patients had baseline invasion of the mesorectum, internal or external sphincter, levator ani, or regional lymph nodes, and although tumor regression after nCRT was favorable, the aforementioned invasion still existed in some patients, which may have contributed to recurrence after LE. In addition, seven patients with recurrence were ypT0 after LE. One possible explanation is that nine patients had tumors involving more than half of the rectal circumference; following nCRT-induced regression, fragmented residual tumor cells may have persisted within fibrotic tissue near or beyond the mesorectal fascia. Given that the LE margin was placed 1 cm beyond the residual tumor scar, the postoperative ypT stage after LE should be interpreted with caution. After recurrence, eight patients underwent salvage surgery and two underwent palliative transverse colostomy. To date, 2 of these patients have died: one at 21 months after salvage surgery, and the other at 11 months after palliative colostomy.

In the univariable Cox proportional hazards regression analysis, none of the evaluated clinicopathological or treatment-related factors were significantly associated with recurrence. Pretreatment circumferential tumor involvement was not significantly associated with recurrence when

analyzed as an ordinal variable, although the hazard ratio increased with each category increment in circumferential involvement (HR, 1.70; 95% CI, 0.96–2.99; $p = 0.068$). Similarly, when circumferential involvement was dichotomized at the 50% circumference threshold, involvement of $> 1/2$ was not significantly associated with recurrence compared with involvement of $\leq 1/2$ (HR, 1.92; 95% CI, 0.50–7.44; $P = 0.344$). Surgeon seniority was also not significantly associated with recurrence (HR, 3.21; 95% CI, 0.83–12.41; $p = 0.091$) (Table 5).

Table 5
Association between selected factors and local recurrence

Variables	HR (95% CI)	P value
Age(per 1-year increase)	1.00(0.96–1.06)	0.780
Sex(Female vs. Male)	0.86(0.24–3.07)	0.812
BMI	0.97(0.82–1.53)	0.763
Preoperative comorbidities(No vs. Yes)	1.27(0.33–4.91)	0.731
Intraoperative distance from tumor to anal verge	0.78(0.49–1.24)	0.290
Pretreatment vertical length of Tumor	0.92(0.51–1.64)	0.766
Pretreatment thickness of Tumor	0.88(0.39–1.99)	0.757
Targeted therapy(No vs. Yes)	0.72(0.15–3.39)	0.674
TNT(No vs. Yes)	0.74(0.20–2.77)	0.658
Interval from radiation to surgery	1.00(0.94–1.08)	0.849
ASA		
I	1(reference)	
II	0.95(0.12–7.65)	0.962
III	0-	0.986
Postoperative CEA	0.98(0.57–1.40)	0.616
Postoperative CA199	1.01(0.96–1.06)	0.626
Pretreatment cT stage		
2	1(reference)	
3	1.04(0.23–4.64)	0.962
4	0.77(0.15–3.85)	0.747
Pretreatment Circumferential tumor involvement per one-category increase*	1.70(0.96–2.99)	0.068
> 1/2 vs. ≤1/2 circumference	1.92(0.50–7.44)	0.344
Circumferential tumor location		
Anterior vs. Non-Anterior	1.19(0.33–4.24)	0.788
Posterior vs. Non-Posterior	0.88(0.25–3.04)	0.837
Lateral vs. Non-Lateral	0.92(0.26–3.23)	0.900

Variables	HR (95% CI)	P value
Surgeon seniority(Less senior surgeons vs. Senior surgeons)	3.21(0.83–12.41)	0.091

^a Pretreatment circumferential tumor involvement was categorized as: 1, < 1/4 circumference; 2, ≥ 1/4 to < 1/2 circumference; 3, ≥ 1/2 to < 3/4 circumference; and 4, ≥ 3/4 circumference.

4. Discussion

This study suggests that LE offers acceptable oncological outcomes and high organ preservation in low-lying LARC patients with cCR/near-cCR after nCRT, including those initially scheduled for APR. The surgical and oncological outcomes were acceptable, with no statistically significant differences observed between the iAPR and iSPS groups.

This study examined a clinically relevant subset of LARC patients who achieved a cCR or near-cCR after nCRT, yet were subsequently found to have residual tumor on postoperative pathology (i.e., non-pCR). In the traditional treatment algorithm, these patients would be directed toward radical resection, such as APR, which is associated with local recurrence rates below 5% in experienced centers. Nevertheless, with recent refinements in neoadjuvant regimens and restaging imaging, cCR or near-cCR is now achievable in 24%–49% of LARC patients, rendering the management of this specific subgroup a subject of an ongoing clinical debate.^[7–8] Consequently, organ-preserving approaches—including watch-and-wait (W&W) and local excision (LE)—have gained increasing acceptance, as they may reduce postoperative morbidity and obviate the need for a permanent stoma. Specifically, the W&W strategy offers the additional advantage of extending the observation window, permitting continued tumor regression after nCRT and potentially avoiding surgery altogether. However, in patients who are incorrectly classified as having a cCR, the adoption of W&W may delay definitive treatment and potentially increase the risk of local regrowth and metastases. Thus, the long-term oncologic safety of the W&W strategy remains to be established.^[9–10] Reported local regrowth rates of 25.2%–31% remain a major obstacle to the broader clinical acceptance of W&W.^{[8],[11]} Furthermore, delayed detection of regrowth during surveillance may permit tumor progression and compromise the feasibility of successful salvage surgery.

In contrast, LE offers the distinct advantage of pathological confirmation of ypT0 status, thereby mitigating the risk of passive surveillance and enabling earlier identification of patients requiring salvage surgery. In the present study, the 3-year cumulative local recurrence rate after LE was 8.0%, comparable to the 7% reported in the GRECCAR 2 trial, and substantially lower than the 25.2% observed in patients managed with W&W alone.^[11–12] Had all patients in our cohort been treated with W&W—with all non-ypT0 cases counted as recurrences—the estimated local recurrence rate would have been 23.9%, far exceeding the actual 8.0% observed after LE. These findings suggest that LE may attenuate the inherent risk of passive surveillance associated with W&W by providing histopathological evidence of residual disease, thereby offering a more informed basis for subsequent management decisions.

Regarding the indications for LE, most studies have been restricted to patients with a post-CRT clinical stage of yT0-1.^[13–14] However, Perez et al.^[15] and Verseveld et al.^[16] extended the indication to include yT2 disease, and some investigators have even performed LE irrespective of the response to nCRT.^[17–18] Current evidence indicates that 3-year DFS and OS after LE range from 76.8% to 91.5% and from 91.0% to 97.5%, respectively; local recurrence rates range from 3% to 15%, and distant metastasis rates range from 3.0% to 19.0%.^{[13–15],[17],[19–20]} In the present study, the 3-year DFS and OS were 87.1% and 99.2%, respectively, with a 3-year cumulative local recurrence rate of 8.0%—figures that are broadly consistent with published data. Moreover, no significant differences were observed between the iAPR and iSPS groups in terms of 3-year OS (98.9% vs. 100.0%, $P = 0.776$) or 3-year DFS (86.2% vs. 91.1%, $P = 0.351$). Most planned rectum-preserving studies have excluded patients with pretreatment cT4 disease. However, previous retrospective evidence suggest that a subset of patients with advanced pretreatment staging—including some with cT4 tumors—may nonetheless achieve a cCR or pathological complete response after nCRT or total neoadjuvant therapy (TNT).^[21–23] Moreover, recent data indicate that although patients with cT4 tumors are less likely to achieve a complete clinical response than cT3 tumors, oncologic outcomes after organ preservation may not be inferior once a complete response is attained.^[22] These observations argue against regarding pretreatment cT4 stage as an absolute contraindication to organ-preserving approaches, as routine APR in such patients would entail unnecessary anal sacrifice and a substantial decrement in quality of life. In our cohort, 47 patients (35.1%) presented with cT4 stage. Had all of these patients undergone routine APR without nCRT, the cumulative organ-preservation rate would have been only 62.7% (84/134), far lower than the actual 3-year cumulative rate of 88.4%. Notably, no significant differences in 3-year outcomes were observed between patients with cT4 and those with non-cT4 stage. Taken together, these findings suggest that LE may represent a feasible organ-preserving strategy for selected patients with pretreatment cT4 disease, provided that strict imaging evaluation and case selection confirm a cCR or near-cCR after nCRT.

Reported postoperative complication rate after LE following nCRT for rectal cancer is notably heterogeneous, with rates ranging from 2.5% to 41.6% across published series.^[24–27] In the present study, the overall morbidity rate was 42.5% (57/134), predominantly attributable to perianal pain (34.3%, 46/134) and delayed rectal wound healing (17.9%, 24/134). The higher-than-expected rate of wound-healing complications in our cohort is likely related to the use of Split-course SBRT, which may induce substantial local tissue edema and impair reparative capacity in a significant number of patients. In response, we adopted a proactive wound-care strategy incorporating transanal irrigation and negative-pressure drainage, and systemic moxifloxacin. While the majority of patients achieved uneventful recovery with these measures, six patients with refractory wound complications required diverting ileostomy, of whom three have yet to undergo stoma reversal.

In this study, 10 patients developed recurrence after LE, and the 3-year cumulative local recurrence rate was 8.0%. Based on clinical review of these 10 patients, we considered two main potential contributors to recurrence. First, although tumor regression after nCRT was generally favorable, scattered residual tumor cells > 1.0 cm beyond the gross lesion may have contributed to local recurrence after LE. Second,

a substantial proportion of patients had pretreatment circumferential involvement of half to full circumference. Following nCRT-induced regression, fragmented residual tumor cells may have persisted within fibrotic tissue in close proximity to, or even beyond, the mesorectal fascia, thereby predisposing to local failure. Although the LE margin was deliberately placed 1 cm beyond the visible residual tumor scar, the actual extent of residual disease may have exceeded this boundary, thereby resulting in positive or close margins and subsequent local recurrence. We therefore recommend that, in patients with baseline involvement of the mesorectum, sphincters, or regional lymph nodes on imaging, these structures should be carefully reassessed following nCRT. If a patient declines radical surgery despite persistent local invasion, the residual disease status and associated oncologic risks should be thoroughly explained and documented via informed consent. Notably, previous studies have demonstrated that fragmented residual tumor may extend up to 3–4 cm from the ulcer edge after CRT, underscoring the importance of rigorous restaging and patient counseling.^[28–29] At present, standardized margin criteria for LE are lacking or vary widely across institutions, which may contribute to the relatively high recurrence rate observed after LE. Two main margin strategies are currently used: (1) a 1-cm margin from the original tumor edge,^{[18],[20]} and (2) a 1-cm margin from the residual lesion.^{[12],[16]} Given the risks of fragmented regression and microscopic lateral intramural residual disease after CRT, Perez et al. proposed a more cautious extended-margin strategy, using an approximately 1.5-cm margin outside the visible residual mucosal abnormality, ulcer, or scar after treatment.^{[28],[30]} Therefore, LE should be applied with caution in patients with advanced baseline staging and extensive circumferential tumor involvement. Further prospective studies are warranted to validate these findings and refine patient selection criteria.

Further analysis of factors potentially associated with local recurrence after LE demonstrated a stepwise increase in local recurrence rates with increasing pretreatment circumferential tumor involvement. The recurrence rate was 2.0% in patients within 1/4 circumferential involvement, 9.7% in those with 1/4 – 1/2 circumferential involvement, and 21.4% in those with complete full-circumference involvement. On univariate Cox regression, each one-category increase in the initial proportion of circumferential tumor involvement was associated with a 70.0% higher in recurrence risk (HR = 1.70, P = 0.068). The recurrence rate was also numerically higher in the > 1/2-circumference group than in the ≤ 1/2-circumference group (13.0% vs. 6.3%), although the difference was not statistically significant (P = 0.344). Given that only 10 local recurrence events occurred in this study, statistical power was limited, and these nonsignificant findings should not be interpreted as evidence that circumferential tumor extent is unrelated to recurrence. Previous studies and guidelines on LE for rectal cancer emphasize that ideal candidates usually have small, mobile tumors with limited circumferential involvement; traditional criteria often recommend a tumor diameter < 3 cm and circumferential involvement < 3/10 to 1/3.^[31–32] GRECCAR 2 also suggested that LE can achieve oncological outcomes comparable with TME when patients are strictly selected, including those with low T2/T3 tumors, good regression after neoadjuvant therapy, residual lesions ≤ 2 cm, and consideration of completion TME for ypT2-3 stage.^[33] A recent multicenter GRECCAR study further showed that a considerable proportion of patients still meet theoretical indications for salvage completion TME after LE, indicating that clinical complete or near-complete

response after treatment does not necessarily translate into pathological safety, nor does it guarantee the absence of residual disease.^[34] Therefore, even when marked local regression is observed after neoadjuvant therapy, patients with extensive initial circumferential involvement may remain at risk of heterogeneous tumor regression, fragmented residual disease within the scar, and microscopic residual disease outside the rectal wall or in the mesorectum. This may explain the trend toward higher recurrence rates among patients with >half-circumference and complete circumference involvement in the present study.

In this study, involvement of the anterior, posterior, and lateral wall was not consistently associated with local recurrence, suggesting that tumor location along the circumferential axis alone may be insufficient for risk stratification. In the present cohort, tumor location was not significantly associated with local recurrence; however, some studies have suggested that anterior rectal tumors carry a higher risk of local failure than those at other locations, possibly because the anterior mesorectum is thinner, facilitating earlier invasion of adjacent pelvic structures such as the prostate or vagina and increasing the likelihood of multivisceral resection. Accordingly, we propose that LE should be undertaken with particular caution when anterior tumors are being considered for organ-preserving approaches.^[35–36] Regarding surgeon-related factors, the local recurrence rate was numerically higher among patients operated on by less senior surgeons than among those operated on by their more senior colleagues, although this difference did not reach statistical significance. This observation underscores the importance of stringent patient selection and standardized surgical training for rectal-preserving LE. Indeed, previous studies on the volume-outcome relationship in colorectal surgery have consistently demonstrated that high-volume centers and experienced surgeons are associated with improved oncologic outcomes.^[37] Taken together, extensive pretreatment circumferential tumor involvement and surgeon seniority may represent potential risk signals for local recurrence after rectal-preserving surgery. However, these findings should be considered hypothesis-generating and require validation in larger, multicenter cohorts with multivariable analysis.

Several limitations of this study should be acknowledged. First, the relatively small sample size limited the statistical power of our subgroup analyses and multivariable modeling. Second, the retrospective, single-center design may have introduced selection bias and limits the generalizability of our findings. Third, the median follow-up duration was relatively short, precluding a comprehensive assessment of long-term oncologic outcomes, including overall survival and late recurrences. Fourth, we did not incorporate validated quality-of-life measures, such as the low anterior resection syndrome (LARS) score, which would have provided important patient-reported outcome data.

5. Conclusion

In this single-center study of 134 patients with low LARC who achieved cCR or near-cCR after nCRT, LE demonstrated satisfactory oncologic outcomes while enabling organ preservation. For patients initially destined for APR, stringent patient selection may allow LE to substantially preserve quality of life without compromising oncologic safety. Patients with advanced baseline staging should undergo intensified

surveillance for early detection of local recurrence. The relatively high rate of wound-healing complications underscores the need for close postoperative monitoring and proactive wound care. Local recurrence remains a concern, with extensive pretreatment circumferential involvement and surgeon seniority emerging as potential risk signals. Future multicenter studies should define standardized inclusion criteria for organ-preserving protocols, refine patient selection and margin thresholds, and identify robust predictors of recurrence, so as to establish a more robust clinical decision-making framework.

Declarations

Competing Interests

The authors have no relevant financial or non-financial interests to disclose.

Ethics Approval

This retrospective study was approved by the Scientific Research Ethics Committee of Fujian Medical University Union Hospital (approval no. 2026KY790) and was conducted in accordance with the Declaration of Helsinki and its subsequent amendments. The requirement for informed consent was waived by the Ethics Committee because of the retrospective nature of the study.

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Author Contribution

Kunming Zhou contributed to study conception, data curation, formal analysis, and drafting of the manuscript. Yang Xiao and Haoyang Ruan contributed to data collection, investigation, and data verification. Ying Huang, Pan Chi, and Shenghui Huang contributed to study conception and design, methodology, supervision, interpretation of the data, and critical revision of the manuscript. All authors read and approved the final manuscript.

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Data Availability

The datasets generated and/or analyzed during the current study are not publicly available because they contain potentially sensitive patient information but are available from the corresponding author on reasonable request, subject to approval by the relevant institutional authorities and compliance with patient confidentiality requirements.

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Figures

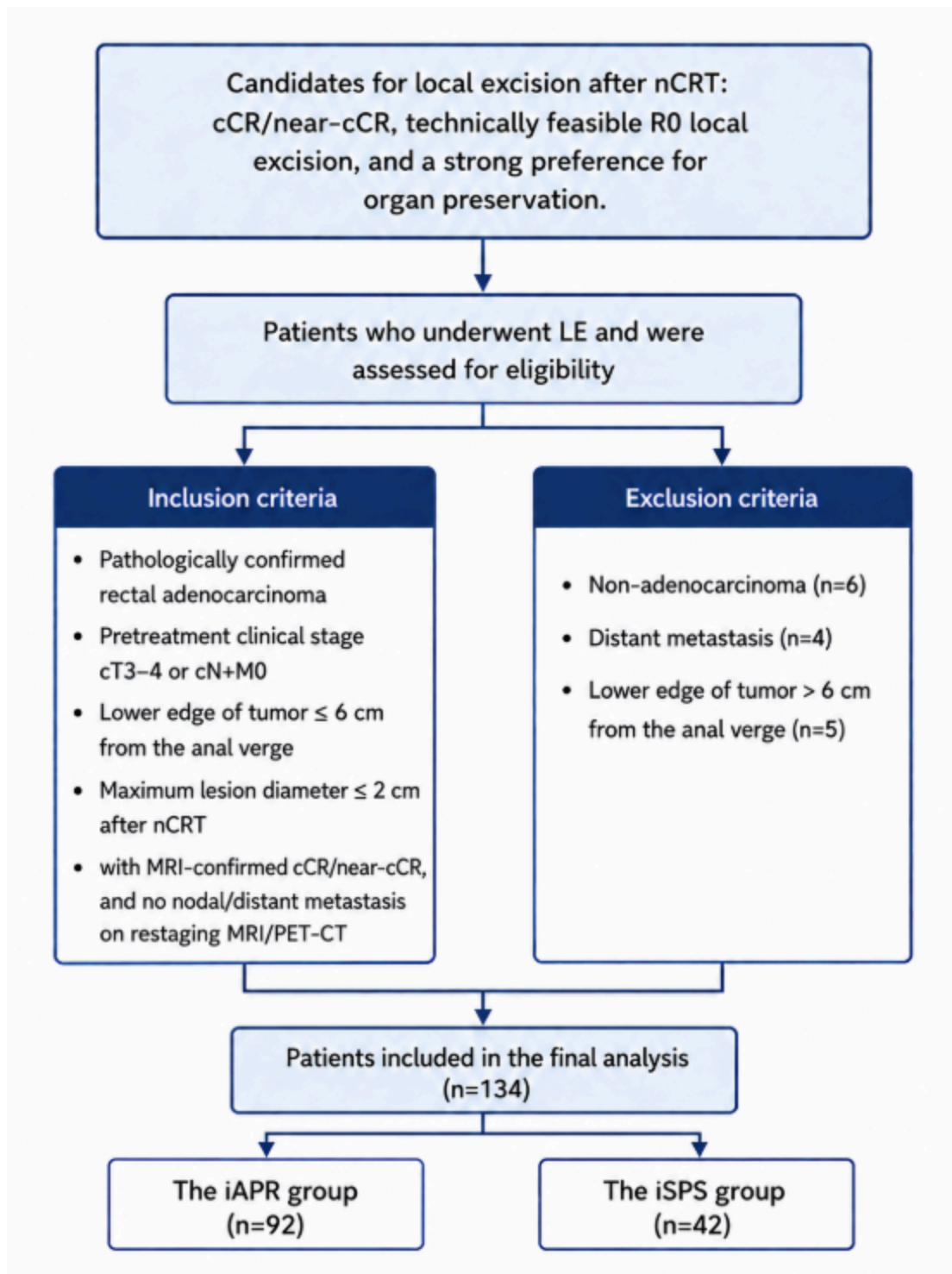


Figure 1

Flow-chart of patient selection.

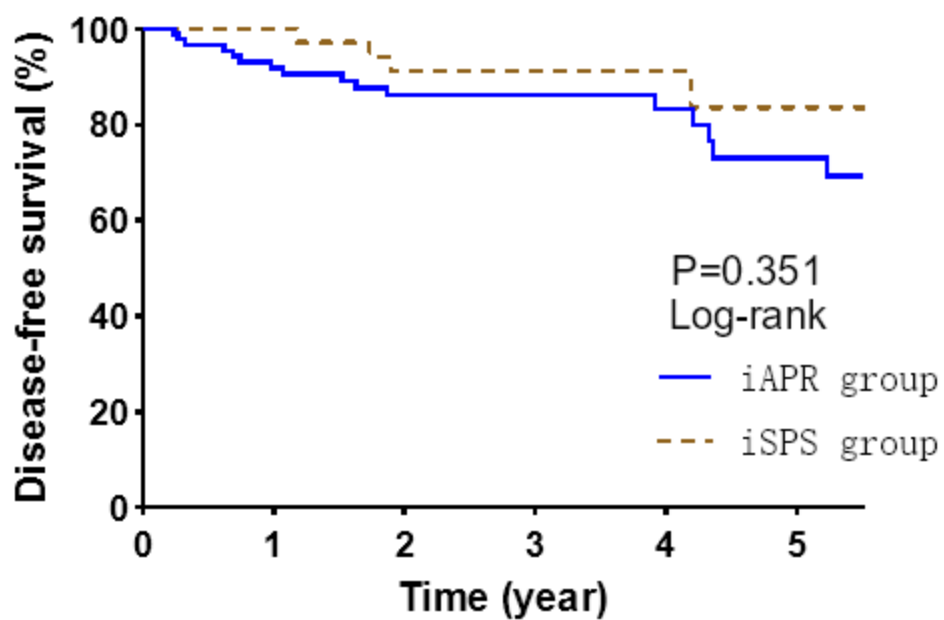
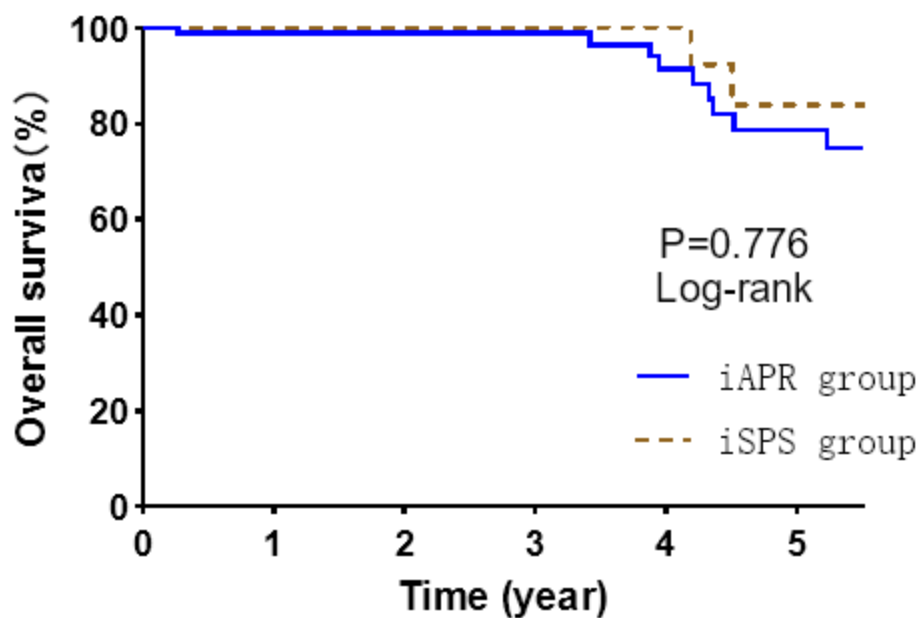


Figure 2

Overall survival and disease-free survival after LE following neoadjuvant therapy in patients with rectal cancer in the iAPR group and the iSPS group.